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ADJUSTMENT OF WHEAT PRODUCTION TO MARKET REFORM IN EGYPT

by

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ABSTRACT

In response to slow growth in the agricultural sector and as part of a general shift towards a more market-oriented economy, the Government of Egypt started liberalizing the agricultural sector in 1987. Controls over wheat production and marketing were eliminated and wheat producer prices were brought closer to international levels. As a result, there has been remarkable increases in wheat crop area and yields, causing wheat production to triple from 1986 to 1998. This study analyzes the results of a survey of 800 Egyptian wheat farmers in order to address three issues that are of interest to agricultural reform policy in Egypt. First, what are the patterns in wheat production and marketing that have emerged following the economic reforms? Second, why is the government unable to purchase more than a small portion of national wheat production? Third, how does wheat supply and input demand respond to wheat and input prices?

The survey indicates that Egyptian wheat production is based on small-scale farms, yet these farms are highly commercialized and the use of inputs such as labor, fertilizer and irrigation, is intensive. The government has problems

reaching its wheat procurement target because most of the wheat produced is consumed in the rural areas and farmers prefer to sell to traders because of better prices and location. Econometric analysis of the survey data suggests that wheat farmers respond significantly to crop and input prices. The estimated own-price supply elasticity is 0.3, implying that the use of price policy alone to pursue wheat self-sufficiency would be costly and ill-advised.

1. INTRODUCTION AND OBJECTIVES

Wheat is the most important staple crop produced in Egypt. It occupies about 32.6 percent of the total winter land area and is mostly used to make bread, a very important component of the Egyptian diet. Average consumption of wheat and wheat products is about 200 kilograms (kg) per capita per year, one of the highest levels in the world.

Prior to 1987, the Government of Egypt (GOE) maintained tight control over the production and marketing of wheat. Farmers were required to allocate 27.5 percent of their agricultural land to the production of wheat. They also had to sell a specific quota of wheat to the government at a fixed price that was, in general, much lower than international prices. During this period, wheat production stagnated while consumption kept rising.

In response to the slow growth in the agricultural sector and as part of a general shift towards a more market-oriented economy, the GOE started liberalizing the agricultural sector in 1987. As a result of the reforms, wheat area restrictions, quotas and fixed procurement prices were removed. Furthermore, a new more liberal framework was established for the trading of wheat grain and flour and the

compulsory delivery program was replaced with an optional program. The procurement price became a floor price and was announced prior to the planting season. It was also brought closer to international prices.

The agricultural reforms initiated in 1987 had a dramatic impact on the wheat sector. From 1986 to 1998, the wheat area doubled, yields increased by 50 percent, and wheat production more than tripled. These remarkable results are attributed to several factors that were associated with the reform programs, including higher relative wheat prices; the adoption of higher yielding seed varieties that were also more resistant to heat, drought, and salinity; the implementation of improved cultivation practices; and a more liberal policy environment which allowed farmers to base their crop planting decisions on market forces and provided them with a greater incentive to grow wheat. The resulting rise in wheat production also led to a significant improvement in the wheat self-sufficiency ratio from 21 percent in 1986 to 46 percent in 1998.

This study analyzes the results of a survey of 800 wheat farmers in order to address three issues. First, what are the patterns in wheat production and marketing that have emerged following the economic reforms? National statistics document the growth in area and yield, but we hope to provide a more detailed picture of the characteristics of wheat farmers, role of wheat in farmers'

crop rotations, patterns of input use, costs of production, and food consumption patterns. Second, why is the government unable to purchase more than a small portion of national wheat production? The government is particularly interested in wheat usage and marketing patterns in order to explain why it has been unable to increase procurement of wheat for the subsidized bread channel. Third, how does wheat supply and input demand respond to wheat and input prices? These parameters are necessary ingredients for informed analysis of wheat policy in Egypt.

The remainder of this paper is organized as follows. The next section describes the design of the wheat producers survey. Section 3 presents the characteristics of the wheat production sector in Egypt based on the survey results. It is followed by Section 4 which analyzes the supply response of farmers to policy changes. The last section concludes the study with policy implications.

2. SURVEY DESIGN

In 1998, a survey of Egyptian wheat farmers was carried out by the International Food Policy Research Institute (IFPRI) and the Ministry of Agriculture and Land Reclamation (MALR) in Egypt, with financial support from the United States Agency for International Development (USAID). The sample of the 1998 Egypt Wheat Producer Survey (EWPS) was designed to be representative of farm households growing wheat in the 1997-1998 season. It uses a four-stage stratified random sample which relies, in part, on lists of wheat farming households prepared by the MALR.

Because each wheat farmer in Egypt did not have an equal probability of being selected for the sample, we need to apply weights in analyzing the data. The weights (also called expansion factors) are the inverse of the probability of selection. Thus, if wheat farmers in a region were under-represented in the sample, the weights compensate for this by giving greater weight to these farms in the calculation of national averages and percentages[1].

The survey used a 23-page pre-coded questionnaire covering the following topics: household characteristics, crop production and sales, wheat usage, wheat and bread consumption, use of labor and other inputs, ownership of assets, credit, sources of income, and farmer perceptions.

3. BASIC CHARACTERISTICS OF WHEAT PRODUCTION

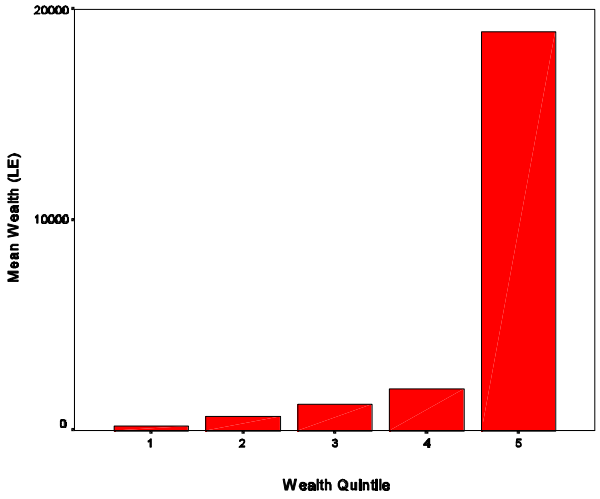
CHARACTERISTICS AND INCOME SOURCES OF WHEAT FARMING HOUSEHOLDS

Analysis of the EWPS suggests that around 54 percent[2] of household heads are literate, even though only 47 percent received any formal education. About 64 percent of wheat farmers consider farming as their main activity; other primary activities include employment in the public and/or service sectors.

In Figures 1 and 2, average wealth and farm size are disaggregated by wealth quintiles[3]. We use the value of consumer durables as a measure of wealth and, thus, a proxy for the standard of living of the households. Average wealth ranges from LE 173 for the poorer households to LE 18,226 for the wealthiest ones. These figures indicate a highly concentrated distribution of wealth where 81 percent of all consumer durables are owned by 20 percent of the wheat farm population. Figure 2 shows that farm size is positively associated with household wealth. Figure 3 indicates that there are differences in wealth distribution by geographical region. Average household wealth is significantly higher in Nubaria

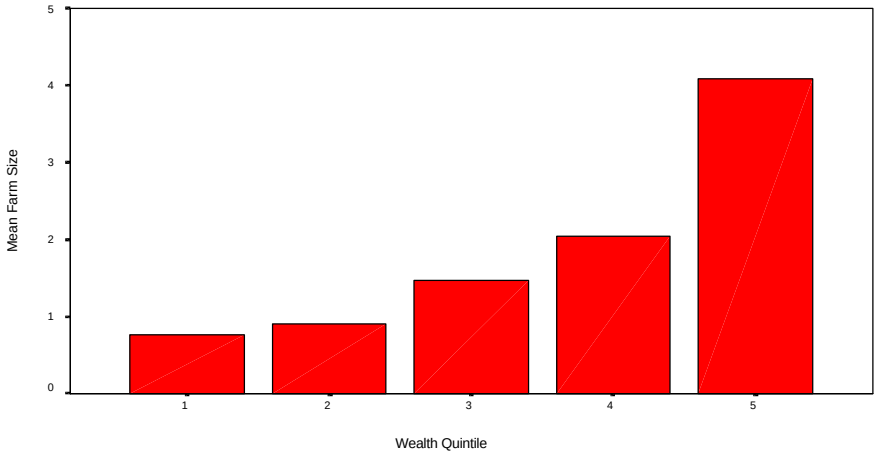
and the Frontier regions compared to other regions[4]. In the Nile valley regions, average wealth is higher in the Delta regions than in Middle and Upper Egypt.

Figure 1–Wealth distribution by wealth quintiles



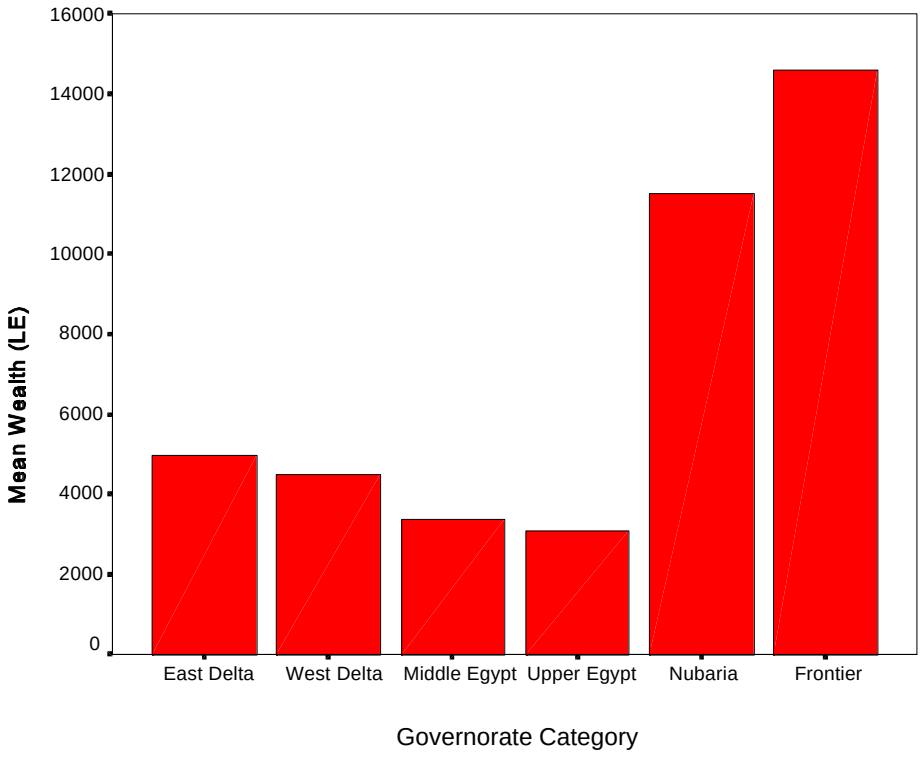
Source: IFPRI 1998 EWPS data

Figure 2–Farm size distribution by wealth quintiles



Source: IFPRI 1998 EWPS data

Figure 3–Geographical distribution of wealth



Source: IFPRI 1998 EWPS data

The major sources of income for wheat farmers are crop sales and consumption of home produced crops. As Table 1 indicates, 97 percent of wheat farm households derive in-kind income from consumption of their own crops while 89 percent of the households receive income from crop sales. Income shares from crop sales and crop home consumption are 30 and 25 percent respectively. Over three-quarters of the wheat farmers had income from livestock activities, but they

account for just 20 percent of income. Wages from non-agricultural activities provide 12 percent of total income.

Table 1–Sources of income and income shares

Income source	Percent of households that receive this type of income (percent of household)	Average income share (percent of total income)
Agricultural wage income	17	4
Other wage income	45	12
Non-farm self-employment	15	4
Crop sales	89	30
Home cons of crops	97	25
Animal product sales	75	11
Animal product home cons.	83	9
Remittances	7	2
Transfers	18	2
Other	4	1
Total		100

Source: IFPRI 1998 EWPS data

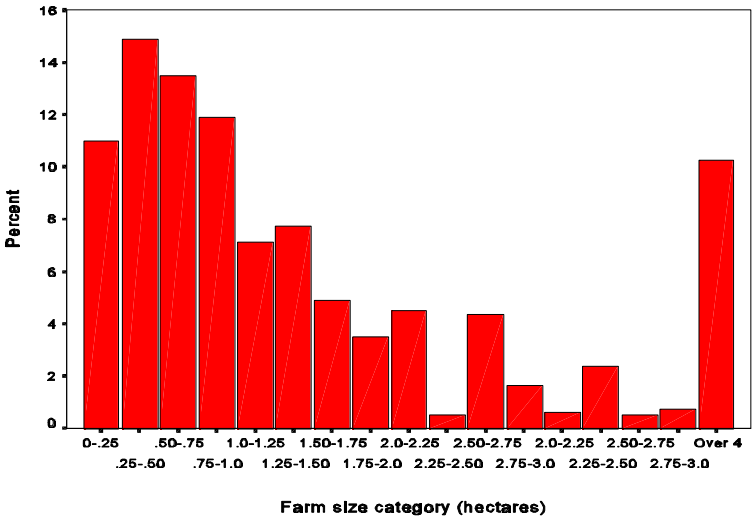
Virtually all wheat farm families (97 percent) own their house, and have electricity (96 percent), but only 16 percent own a telephone. However, over 50 percent of them do have access to a telephone. The average distance from the house to a paved road and a bakery are 0.8 and 3.1 km, respectively.

LAND USE AND CROP PRODUCTION

The vast majority of Egyptian wheat farms are small, irrigated, and owner-operated. The average farm size is 1.7 hectares (ha), but 50 percent cultivate less than 1.0 ha (see Figure 4). The largest farms are found in Nubaria and the Frontier, where the averages are over 2.5 hectares.

Figure 4–Distribution of wheat farms by farm size

Source: IFPRI 1998 EWPS data



Irrigation is almost universal in Egyptian agriculture, allowing the cultivation of summer and winter crops and a cropping intensity ratio of 1.9[5]. More than three-quarters of the land of wheat farmers is irrigated by pump from a canal. One

exception to this pattern is that in the Frontier, irrigation water comes from wells, both private and public.

The survey also confirms that wheat plays an important role in wheat farmers crop rotations. The most common winter-summer rotations are wheat-rice (20 percent of the cultivated area), berseem-cotton (12 percent), wheat-maize (10 percent), and berseem-maize (8 percent). Four fifths of the wheat farmers in Egypt grow wheat every year. This implies that although 1.67 million households grow wheat in a given year, approximately 2 million households grow wheat overall.[6] Interestingly, only 58 percent of the smallest wheat farmers grow wheat every year, compared to 92 percent in the category of the largest wheat farmers. The explanation appears to be that small farms have fewer plots (just 2 on average) so it is more difficult to grow wheat every year and rotate winter crops.

Wheat farmers devote one half of their winter crop land (or slightly less than one quarter of their total sown area) to wheat (see Table 2). In terms of the value of production, the most important crops grown by wheat farmers are cotton (24 percent of the total), wheat (19 percent), and rice (15 percent). Cotton, fruits, and vegetables account for a larger share of the value of production than of area because value per hectare is higher than for staple foods.

Table 2–Measures of the importance of each crop to wheat farmers

	Percent of households growing	Percent of sown area	Percent of value of crop production
Rice	40.3	12.3	15.3
Wheat	100	23.6	18.7
Maize	60.1	11.9	7.8
Sorghum	17.6	4.7	2.8
Fava beans	15.2	3.7	2.5
Other legumes	5.8	1.6	1.4
Tomatoes	3.9	1.8	3
Other vegetables	10.6	2.9	4.3
Fruit	5.9	2	3.4
Cotton	46	13	23.5
Berseem	76.5	16.8	11.6
Feed maize	10.7	1.5	0.6
Other crops	14.1	4.2	5.1
Total	406.7	100.0	100.0

Source: IFPRI 1998 EWPS data

The survey results also highlight the intensity of wheat production in Egypt (see Table 3). The average wheat farmer harvests crops worth close to LE 12,000, though there is considerable variation. About 23 percent produce less than LE 3,000, while 9 percent of them produce more than LE 30,000 worth of crops. The average wheat farmer harvests 3.2 tons of wheat from 0.76 hectares of planted wheat, implying an average yield of 4.3 tons/hectare. Similarly, the average yields among wheat farmers are 7 tons/hectare for rice paddy, and 4.8 tons/hectare for maize.

Finally, the survey indicates that Egyptian wheat farmers are highly commercialized (see Table 4). The market surplus ratio[7] is between 50 and 70 percent for the main food grains: rice, wheat, maize, and sorghum. For legumes, fruits, and vegetables, 85-98 percent of the harvest is sold. Virtually all (99 percent) cotton is sold. This pattern is not the result of a few large producers, as shown by the high proportion of producers that sell some of their output. Even for the basic grains (wheat, maize, and sorghum) the proportion of growers that sell part of their crop is over half. The least commercialized crops are berseem and feed maize, grown mainly for on-farm use as animal feed.

Table 3–Average area, production, yield, value, and value per hectare by crop

	Sown area (ha/hh)	Production (mt/hh)	Yield (mt/ha)	Value per farm (LE/hh)	Value per hectare (LE/ha)
Rice	0.39	2.76	7	1,808	4,581
Wheat	0.76	3.24	4.28	2,208	2,915
Maize	0.38	1.81	4.76	922	2,420
Sorghum	0.15	0.52	3.45	330	2,205
Fava beans	0.12	0.29	2.44	296	2,520
Other legumes	0.05	0.17	3.36	166	3,289
Tomatoes	0.06	1.04	18.47	357	6,358
Other vegetables	0.09	1.17	12.36	505	5,356
Fruit	0.06	0.68	10.49	398	6,163
Cotton	0.42	0.96	2.29	2,764	6,615
Berseem	0.54	*	*	1,364	2,536
Feed maize	0.05	*	*	71	1,456
Other crops	0.13	4.7	35.01	598	4,454
Total	3.20	17.42	8.01	11,787	3,913

Source: IFPRI 1998 EWPS data

* The berseem and feed maize quantities could not be converted to metric tons.

Table 4–Characteristics of crop sales by crop

	Pct. of producers selling	Pct. of households selling	Production (mt/hh)	Sales (mt/hh)	Mkt surplus (%)	Value of sales (LE/hh)	Pct. value of sales
Rice	82.2	33.2	2.76	1.85	67	1147	13.8
Wheat	54.7	54.7	3.24	1.67	51	1132	13.6
Maize	59.0	35.5	1.81	1	55	482	5.8
Sorghum	55.5	9.7	0.52	0.32	62	197	2.4
Fava beans	80.9	12.3	0.29	0.25	86	254	3.1
Other legumes	100.0	5.8	0.17	0.16	96	160	1.9
Tomatoes	95.9	3.8	1.04	0.99	95	338	4.1
Other vegetables	98.4	10.8	1.17	1.15	98	498	6.0
Fruit	90.4	5.9	0.68	0.66	98	393	4.7
Cotton	99.6	46	0.96	0.95	99	2736	32.9
Berseem	33.4	25.5	*	*	30	387	4.7
Feed maize	20.3	2.2	*	*	14	9	0.1
Other crops	94.2	13.3	4.7	4.7	100	578	7.0
Total		258.7			73	8,311	100.0

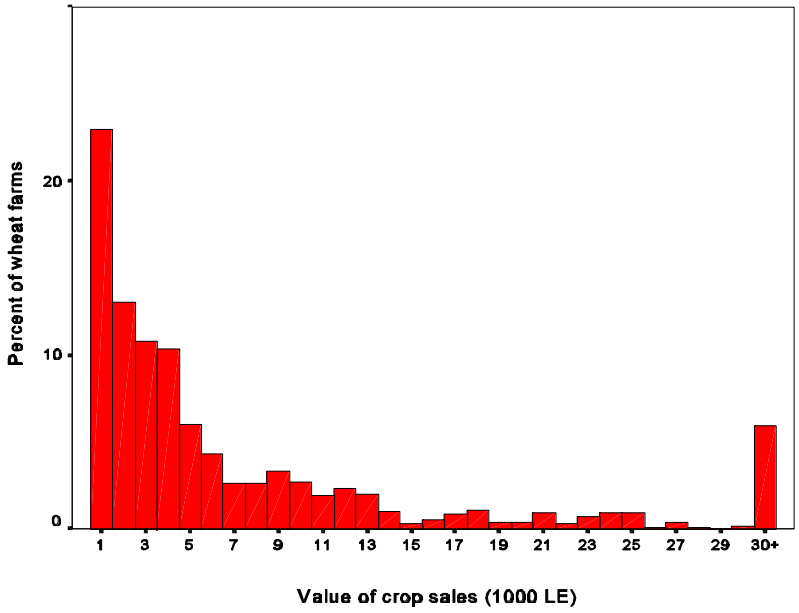
Source: IFPRI 1998 EWPS data

* The berseem and maize quantities could not be converted into metric tons.

The average value of crop sales is LE 8,311 per wheat farm, although over half of wheat farmers sell less than LE 4,000 worth of crops. At the other extreme, roughly five percent of wheat farmers have annual crop sales of more than LE 30,000. By comparing the average value of sales to the average value of production, we estimate that 70 percent of the crop production of Egyptian wheat farmers is sold. Again, most households sell a smaller percentage of their harvest, but the patterns of large farms tend to dominate the average. Figure 5 shows the distribution of wheat farms according to the overall marketed surplus, defined as the value of crop sales as a percentage of the value of crop

production. The market surplus ratios are highest in Nubaria and the Frontier, and are higher (on average) among large and wealthy farmers.

Figure 5–Distribution of wheat farms by value of crop sales



Source: IFPRI 1998 EWPS data

INPUT USE

Seeds and Fertilizers

Before the agricultural reforms of 1987, about 61 percent of the total cultivated wheat area in Egypt was sown with lower-yielding, longer stalked wheat varieties (Sallam et al. 1989). Low government-set prices of wheat skewed farmers'

incentives such that they preferred to sow long stalked, large straw producing traditional varieties that sold at a market price of LE 160 per mt, while the wheat itself could only be sold at the fixed price of LE 120 per mt (Harik 1996). With the liberalization of wheat and other agricultural markets, the adoption of higher-yielding, heat and pest tolerant, semi-dwarf varieties began to take off.

The primary type of bread wheat variety currently used by farmers in Egypt is Sakha 69 (See Table 5). About 48 percent of the wheat farmers purchased Sakha 69 in the 1997/98 cropping season. It is the most intensively cultivated seed variety in the Delta and Frontier regions, and to a lesser extent in Middle Egypt. Older Sakha varieties, such as Sakha 8 and Sakha 61 continue to be sown, primarily in Nubaria, the Frontier and the West Delta. The second most popular seed variety is Giza 164. This higher yielding, rust-resistant and heat-tolerant bread wheat variety, is sown by nearly 40 percent of wheat farmers in Upper Egypt and 10 percent of wheat farmers in Middle Egypt.

Table 5–Percentage of farmers applying wheat seed by variety and region

Variety	East Delta	West Delta	Middle Egypt	Upper Egypt	Nubaria	Frontier	Overall
Traditional	0.1	1.9	1.0	10.2	0.0	0.0	3.1
Beni Suef	0.0	0.0	23.1	0.0	0.0	0.0	3.4
Giza 164	0.0	0.0	9.8	39.7	0.0	0.0	10.2
Sakha 8	1.9	6.0	0.0	0.5	77.2	15.0	3.2
Sakha 61	1.7	10.3	0.0	0.0	0.0	0.0	4.0
Sakha 69	67.2	68.0	37.1	0.9	0.0	49.4	47.9
Sidas	1.3	1.1	13.6	14.4	14.8	0.0	6.0
90s MVs	0.0	4.3	0.0	0.5	0.0	0.0	1.6
Older MVs	0.4	0.3	0.0	0.0	0.0	6.2	0.2
Stored seeds	27.4	8.1	15.3	33.9	8.0	29.4	20.4

Source: IFPRI 1998 EWPS data

Beni Suef and Sohag are durum wheat varieties. Unlike bread varieties, durum wheat is primarily milled into semolina flour for the production of pasta products. Beni Suef is currently cultivated in Middle Egypt - primarily Minia, where about 23 percent of wheat farmers grow it. A further 20 percent of the wheat farmers use various varieties of seeds stored from the previous years harvest. Use of stored seed is most common in the Frontier, Upper Egypt, and the East Delta. Lastly, while about 3 percent of farmers continue to use traditional varieties in Egypt, 9 percent of the farmers in Upper Egypt continue to sow Giza 156 and Baladi wheat varieties, which are more susceptible to lodging and typically have lower yields than the newer modern varieties.

Nearly 55 percent of the farmers obtain their wheat seeds from cooperatives and about 14 percent purchase them from traders. A further 27 percent obtain their seed from either other farmers or from their pervious years' harvest. Cooperatives and traders provide mainly modern varieties, while other farmers provide over 85 percent of the traditional varieties purchased by farmers. Farmers typically travel about 0.5 km to purchase seeds, with cooperatives usually closer than traders and village banks. Seeds retail for about LE 1.47 per kg on average. Application rates are about 162 kg/ha.

Nitrogenous fertilizer application rates in Egypt are among the highest in the world. According to the EWPS, the three most widely used fertilizers by Egyptian wheat farmers are ammonium nitrate (AN), urea, and single superphosphate (SSP) (See Table 6). In the 1997/98 cropping year, nearly 100 percent of wheat farmers used some form of nitrogenous fertilizer - usually urea or AN - and 44 percent used SSP on their wheat fields. Application rates are about 394 kg/ha for urea and 336 kg/ha for SSP. Less than one percent apply potash to their wheat fields. As Table 6 shows, urea is used most intensively in Middle and Upper Egypt, while AN and SSP are the predominant fertilizers used in the Delta. In the newly reclaimed lands of Nubaria, because of the lower soil fertility, all farmers applied AN and SSP to their wheat fields. In addition, a number of farmers in Nubaria applied ammonium sulfate and potassium sulfate to their

fields, presumably to help deal with sulphur and/or potassium deficiencies within the soil. In the Frontier, wheat farmers rely more on manure to provide nutrients for plant growth than on inorganic fertilizers.

About 45 percent of the farmers purchase their fertilizer from cooperatives and 41 percent from agricultural traders. Farmers rely principally on inorganic fertilizers and crop rotation to maintain the fertility of their wheat fields; use of manure is limited.

Table 6–Fertilizer usage by type and region (Percentage of wheat farmers)

	Region						Overall
	East Delta	West Delta	Middle Egypt	Upper Egypt	Nubaria	Frontier	
Urea	42	47	73	90	0	32	58
Ammonium nitrate	74	60	42	44	100	0	58
Ammonium sulphate	0	0	0	0	25	0	0
Superphosphate	64	65	18	4	100	32	44
Potassium sulphate	0	0	2	0	10	0	0
Other fertilizer	6	5	5	2	0	0	5
Manure	10	6	11	8	17	68	9

Source: IFPRI 1998 EWPS data

Labor

Unlike many other countries in the world, Egypt produces wheat in a labor intensive manner. On average, farmers use 79 person-days of labor on each hectare of wheat during the growing season. The single most labor intensive

activity is harvesting; over 23 person-days of labor are devoted to harvesting one hectare of wheat and 16 person-days to threshing.

Labor use varies with farm size. As shown in Table 7, households with small farms use more labor, most of which is family labor, to produce a hectare of wheat. Large farms, by contrast, use less labor per hectare, most of which is hired, and more machinery. Wage rates in wheat production are about LE 8 to 15 per day, depending on the activity and the period of the year.

Table 7–Labor usage in wheat production by labor type and total area category

	Farm size quintile					Overall
	Smallest	2	3	4	Largest	
Family	65.6	48.1	35.4	26.5	14.4	40.6
Hired	36.3	33.9	36.1	32.2	43.3	36.2
Exchange	2.3	3.5	1.3	1.9	.2	1.9
Total	104.2	85.5	72.8	60.6	57.8	78.7

Source: IFPRI 1998 EWPS data

Agricultural machinery and animal ownership

Shortages of family labor and high wage rates for hired labor during peak periods have been an impetus for the mechanization of Egyptian agriculture (Khan 1993). Tractors are used by virtually all wheat farmers (99 percent), albeit for an average of just three-quarters of a day over the wheat season. Despite high usage in wheat farming, tractors are owned by only 14 percent of wheat farmers;

the remainder rent. Wealthier and larger farmers are more likely to own a tractor than poorer households. On average, the daily rental rate for a tractor is LE 116. Although 93 percent of wheat farmers use pumps to irrigate their wheat fields, only 58 percent own a water pump. The remainder rent pumps from friends and neighbors.

Nearly all wheat farmers in Egypt own poultry or other fowl, and goats or sheep (see Table 8). About 83 percent of wheat farmers own a mule or a donkey, and 76 percent use them in their wheat farming activities.

Table 8–Use and ownership of animals by type

Animal traction	Percent who own	Number owned	Percent who used own	Percent who rented	Percent who used
Camel	3	1.2	3	4	7
Ox/Cow/Bull	77	3.3	3	0	3
Horse	3	1.6	1	0	1
Mule/Donkey	83	1.3	73	4	76
Sheep/Goat	100	6.2			
Fowl	100	44.3			

Source: IFPRI 1998 EWPS data

Credit

According to the EWPS, few wheat farmers are able to purchase inputs on credit. Cash transactions account for 92 percent of fertilizer purchases, 95 percent of seed purchases, and 98 percent of the purchases of agricultural

chemicals. On the other hand, 24 percent of the wheat farmers were able to obtain a loan for the 1997-98 season, and 30 percent had received a loan within the past five years. Virtually all the loans (96 percent) came from the Principal Bank for Development and Agricultural Credit (PBDAC) which offers loans at below-market interest rates (11-13 percent per year). The average loan is for LE 3,454 with a repayment period of 302 days.

Access to credit varies according to household wealth, in part because PBDAC uses the amount of land under cultivation as an important criterion in the allocation of credit. Just 12 percent of the poorest wheat farmers had obtained a loan compared to 24 percent on average. Furthermore, poorer farmers received smaller loans, the average amount one third less than the overall average. Poorer households were also more likely to use the loans for non-business purposes. Twenty four percent of the poorest loan recipients used the loan for consumption or home improvement, compared to just 6 percent of the richest loan recipients.

In addition, access to credit varies by region. Government policy ensures that wheat farmers in Nubaria are favored with good access to low-interest credit. A majority of the Nubaria wheat farmers in the EWPS sample obtained a loan in 1997-98, and the average interest rate was just 10 percent. In contrast, the

proportion of wheat farmers receiving loans in the two Delta regions was less than 15 percent.

Land

As part of the economic reforms, land rental prices have been liberalized. Wheat farmers in the EWPS report that land rents have increased by about 76 percent since 1992-93, equivalent to a 17 percent increase in real terms. Increases have been particularly large in the governorates of Giza, Qalubia, and Beheira, which are close to Cairo, and where agricultural land is relatively scarce. About 62 percent of the wheat farmers in Egypt report that the removal of the land rent ceiling has had little effect on their household. Furthermore, relatively few of the poorest households (30 percent) indicated that the new land law had made them worse off.

These results can be better understood in light of land ownership patterns. According to the EWPS, the overwhelming majority (90 percent) of the land cultivated by wheat farmers is owned by the farm household. Just 8 percent is rented and the remainder is sharecropped. Not surprisingly, the proportion of rented area is much higher (about 24 percent of total land area) for the poorer than the wealthier households (about 4 percent). This implies that about three quarters of the poorest wheat farmers are not directly affected by the

liberalization of land rents. The survey also reveals that a significant portion of the rented land is rented by relatively large and wealthy farmers. For example, almost 45 percent of the land rented by Egyptian wheat farmers is rented by those in the top two quintiles. This suggests that the benefits of land rent controls were not necessarily well targeted to the poor.

COSTS AND RETURNS OF WHEAT PRODUCTION

In this section, we describe the revenue and costs associated with wheat production in Egypt. We calculate the gross value of wheat production as the value of wheat sales, the value of wheat retained for home consumption, and the value of wheat stalks produced. The returns to family labor and family-owned assets are calculated as the gross value of wheat production minus the cost of hired labor, seed (including retained seed), fertilizer, other inputs, land rental, equipment rental, and animal rental for wheat production. We do not attempt to estimate the overall cost of production because of the conceptual and practical difficulties of imputing a value for family labor and family-owned land.

The gross revenue from wheat production, defined as the value of wheat and stalk production, is LE 2,642 per farm or LE 0.81 per kilogram of wheat produced (see Table 9). The value of wheat grain is LE 0.68 per kilogram, but stalks add another 19 percent to the value of the grain.

Table 9–Revenue and costs of wheat production

	LE/farm	LE/ha of wheat	LE/kg of wheat	LE/person-day family labor	Pct of revenue	Pct of costs
Value of Output	2,642	3,798	.81	178	100.0	.
Variable costs	937	1,347	.29	63	35.5	100.0
Hired labor	251	360	.08	17	9.5	26.8
Seeds	129	185	.04	9	4.9	13.8
Fertilizer	212	305	.07	14	8.0	22.6
Ag chemicals	54	78	.02	4	2.0	5.8
Equipment rental	190	273	.06	13	7.2	20.2
Land rental	68	98	.02	5	2.6	7.3
Other inputs	33	48	.01	2	1.3	3.5
Returns to land, management and family labor	1,705	2,452	.53	115	64.5	.

Source: IFPRI 1998 EWPS data

Variable costs of production are 36 percent of revenue. The largest cost categories are hired labor (27 percent of costs), fertilizer (23 percent), and equipment rental (20 percent). Nitrogen fertilizers such urea and ammonium nitrate are the largest item in fertilizer costs, while threshing and tractor services are the most important types of equipment rental.

Net revenue (gross revenue minus variable costs) averages 64 percent of revenue. This represents the implicit “wages” of family labor, the implicit “rent” on family-owned land, and the return on family-owned equipment and animals used in wheat production. It seems that agricultural reforms, liberalization, and

the use of modern technology have all contributed to changes in farmer profitability. About 64 percent of households reported that wheat profitability has increased since 1995.

Looking at crop budgets across farm-size categories, gross revenue per ton is essentially constant, being determined by market prices, but variable costs decline with farm size. This is largely due to the fact that larger farms rent a smaller share of the cultivated land. Thus, returns to family labor and family-owned assets rise from LE 473/ton for the smallest farm-size category to LE 551/ton in the largest (see Table 10). Gross revenue per hectare is somewhat higher among smaller farms due to more intensive cultivation and higher yields. However, per-hectare costs are also higher among small farms, largely due to the cost of renting land. The combined effect is that the net revenue is somewhat (13 percent) higher for the largest farm-size category than it is for the smallest. And finally, the returns per person-day rise sharply as farm size increases. This is not surprising since labor productivity is strongly influenced by the amount of other factors of production per worker, and by definition large farms offer more land per family member.

Table 10–Revenue and costs of wheat production per unit of input by farm size category

	Farm size category					
	Smallest	**2**	**3**	**4**	**Largest**	**Overall**
Revenue per metric ton	807	806	817	795	824	810
Cost per metric ton	334	338	321	274	272	290
Returns per metric ton	473	468	496	522	551	530
Revenue per hectare	3,878	4,445	4,037	3,967	3,593	3,798
Cost per hectare	1,606	1,866	1,586	1,366	1,187	1,347
Returns per hectare	2,272	2,578	2,451	2,601	2,405	2,452
Revenue per person-day	65	93	115	170	379	178
Cost per person-day	27	39	45	58	125	63
Returns per person-day	38	54	70	111	253	115

Source: IFPRI 1998 EWPS data

WHEAT USAGE AND MARKETING

In 1998, the average quantity of wheat harvested per wheat farm household was 3.25 tons (see Table 11). Extrapolating to the national level, this implies a harvest of 5.4 million tons of wheat. Of the total quantity harvested, about 52 percent was sold, 31 percent was used for household consumption, 7 percent was stored for other uses, and 6 percent was given out as gift or other. The remaining 5 percent was used to pay farm workers or landlords, stored for seed, and used as animal feed.

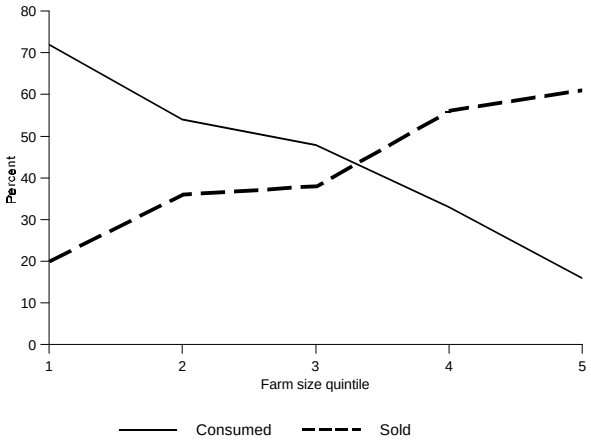
Table 11–Average wheat usage in 1998

Activity	Quantity per wheat farm (kg)	National quantity (mmt)	Percent of quantity harvested
Harvested	3252	5.42	100
Sold for cash	1701	2.83	52.3
Consumed in household	993	1.65	30.6
Stored for other uses	230	0.38	7
Used for gifts and other	185	0.31	5.7
Used to pay workers	83	0.14	2.6
Stored to use as seed	32	0.05	1
Used as animal feed	14	0.02	0.4
Used to pay land rent	11	0.02	0.3

Source: IFPRI 1998 EWPS data

The share of wheat used for household consumption is highest for small farmers and tends to decrease with farm size (see Figure 6). Conversely, the share of wheat sold increases with farm size. In small farms, most wheat is used for subsistence and therefore only a small amount of wheat harvested is left to be sold. As farm size increases, however, once wheat used for household subsistence has been allocated, the rest of the wheat is sold. Therefore, wheat sales tend to increase more than proportionately with farm size.

Figure 6–Percentage of wheat consumption and sales over total harvest by farm size



Source: IFPRI 1998 EWPS data

As expected, we also find that the frequency and volume of wheat sales is correlated with farm size. Whereas 63 percent of households in the smallest farm-size quintile never sell wheat, about 67 percent of the largest farm-size quintile always sell wheat. Most small-scale farmers grow wheat for subsistence. As farm size increases, farmers sell the additional volume of wheat that will not be used for own household consumption. On average, about a little less than one-third of the farmers never sell wheat, and a little more than one-third always sell wheat. The rest either sell rarely, sometimes, or frequently. On a volume basis, a little more than one-third of all farmers sell more than 50 percent of their wheat; another one-quarter of farmers sell less than 50 percent; and less than 10 percent of all farmers sell all their wheat. However, even if most farmers sell less

than 50 percent of their wheat, those that sell more wheat own larger farms so that overall more than 50 percent of all wheat production is sold.

As noted earlier in Table 11, 52 percent of the wheat harvested by farmers is sold. Table 12 below shows the characteristics of the wheat sale transactions by the type of buyer. The types of wheat buyers include private traders, neighbors, public mills, cooperatives, the village banks, the MALR, and others. The Ministry of Trade and Supply (MOTS) uses the public mills, the cooperatives, and the village banks (which are the branches of the PBDAC) to buy the wheat from the farmers on its behalf. This government procured wheat is then channeled to the public mills to make the subsidized 82 percent wheat flour for the baladi bread and flour subsidy program. The MALR, on the other hand, contracts with large scale farms to multiply wheat seeds.

The numbers in Table 12 indicate that about 39 percent of the wheat farm households sell to traders, while only 6 percent sell to their neighbors, and less than 5 percent sell to either the mills, the cooperatives or the village banks. Private traders receive two-thirds of all the wheat sold by farmers, or the equivalent of 1.88 mmt of wheat on a nation-wide basis. The next largest marketing outlets for farmers are the mills and the village banks, each buying

about 9 percent of the marketed wheat. The cooperatives bought just 5 percent of the wheat sold.

Table 12–Characteristics of wheat sale transactions by type of buyer

Type of buyer	Percent of households selling	Average volumes sold per household (kg)	National sales (mmt)	Percent allocation among buyers
Private trader	39.1	1,127	1.88	66.3
Neighbor	6	41	0.07	2.4
Mill	3.9	156	0.26	9.2
Cooperative	4.2	85	0.14	5
Village bank	4.8	156	0.26	9.2
MALR	0.5	98	0.16	5.8
Other	0.6	37	0.06	2.2
Total	58.9	1,700	2.83	100

Source: IFPRI 1998 EWPS data

Results from a previous IFPRI study on wheat traders in Egypt (Badiane and Kherallah 1998) indicate that about 61 percent of the wheat bought by traders is in turn sold to the government through the mills or the PBDAC. This implies that about 1.15 mmt of the wheat bought by traders in 1988 was potentially sold to the MOTS. Based on these estimates, the total quantity of wheat sold to the government (directly or indirectly) would be about 1.8 mmt.

One question of interest to the government is why farmers sell primarily to traders rather than to the cooperatives, mills, or village banks that facilitate direct government procurement. The EWPS asked farmers why they choose to sell to

one buyer rather than another. Two main reasons were good prices (60 percent) followed by close location (23 percent). Regarding price, the average price paid to farmers by traders (LE 0.67 per kg) was at least as high as the price paid by regular government outlets such as the mills, village banks, and cooperatives (LE 0.64 to 0.66 per kg). It is also toward the top of the range of government procurement prices, which range from LE 0.63 to LE 0.67 per kg depending on quality.

Regarding the location of sale, traders usually purchase wheat on the farm (64 percent) or at a market (25 percent). In contrast, in order to sell to a mill, cooperative, or village bank, it is necessary for the farmer to transport the harvest to these sites. These findings confirm earlier reports by Badiane and Kherallah (1998) that farmers prefer to deal with traders because they offer better prices, they buy smaller quantities, and they pick up the wheat from the farmers' dwelling saving on transport costs. In some cases, traders also give an advance to the farmer.

On-farm wheat storage is quite common. Almost all wheat farmers use their own house to store their wheat (the exception is the Frontier, where most farmers do not have wheat storage capacity). Farmers very rarely rent storage space. The average quantity of wheat in storage is very seasonal. The quantity of wheat

stored reaches a peak after harvest in April/May at about 1.1 to 1.4 mt and declines gradually down to 150 kgs just before the next harvest season of the following year. Most of the wheat (86 percent) is stored for consumption throughout the year rather than for sale.

WHEAT CONSUMPTION PATTERNS

In order to shed more light on wheat marketing decisions, this section describes the consumption patterns of staple grains (wheat, rice, and maize) among wheat farmers. The most widely consumed grain product in our sample was home-baked bread from wheat produced on the farm, reported by 91 percent of the households. As shown in Table 13, most households also make other wheat products from their own harvest (65 percent), bake bread from purchased flour (70 percent), buy rice (62 percent), and buy baladi bread (59 percent)[8]. A minority of wheat farmers consume rice that they produced, purchased fino bread, and bread from purchased wheat.

Table 13–Percentage of households that consume different grain products

	Pct consuming one or more months per year	Pct consuming seven or more months per year	Pct consuming every month of the year
Purchased baladi bread	59.2	43.3	37.2
Purchased fino bread	30.1	19.8	9.8
Bread from bought flour	70.0	23.8	18.1
Bread from bought wheat	15.5	7.2	3.1
Purchased rice	62.4	56.5	54.5
Bread from own wheat	90.9	78.3	58.3
Other from own wheat	64.6	30.8	20.9
Rice from own harvest	42.4	40.8	38.4

Source: IFPRI 1998 EWPS data

Baladi bread is purchased by somewhat more than half of the wheat farmers, regardless of wealth category (see Table 14). In contrast, the proportion of households buying fino bread rises from just 7 percent in the poorest category to 55 percent in the richest. This reflects the higher cost of fino bread which makes it a "luxury" good among grain products. The percentage of wheat farm households consuming home-made bread from purchased flour and purchased wheat tends to decline in the high-wealth categories, reflecting the higher opportunity cost of time of these households.

Table 14–Percentage of households that consume different grain products by wealth category

	Wealth category				
	Poorest	**2**	**3**	**4**	**Richest**
Purchased baladi bread	56	66.3	50.8	57.7	64.8
Purchased fino bread	6.8	33.8	21.7	31.1	55.0
Bread from bought flour	81.8	75.5	62.0	67.1	64.5
Bread from bought wheat	22.4	26.7	14.1	9.6	6.3
Purchased rice	70.4	63.3	55.2	65.8	58.8
Bread from own wheat	93.6	97.5	81.0	93.8	88.5
Other from own wheat	56.2	61.3	63.3	68.6	73.3
Rice from own harvest	37.0	47.0	39.1	35.9	52

Source: IFPRI 1998 EWPS data

The EWPS highlights the high level of wheat consumption in rural Egypt. Egyptian wheat farmers purchase 242 loaves of baladi bread per person per year or 31.5 kg/person/year. Among those that buy it, the average is 410 loaves/person/year or 53 kg/person/year. The average consumption of fino bread is about one half that of baladi bread (84 loaves/person/year or 15 kg/person/year) (see Table 15).

Table 15–Average annual consumption of different wheat products

	Annual consumption in original form			Annual consumption in wheat equivalent		
	kg/household	**kg/person**	**Percent**	**kg/household**	**kg/person**	**Percent**
Purchased baladi bread	211.6	31.5	14.0%	194.6	28.9	12.5%
Purchased fino bread	82.6	15.2	5.5%	86.7	16.0	5.6%
Purchased flour	197.0	25.2	13.1%	260.1	33.2	16.7%
Purchased wheat	66.8	10.1	4.4%	66.8	10.1	4.3%
Own wheat	949.4	126.2	63.0%	949.4	126.2	61.0%
Total	1507.3	208.2	100.0%	1557.6	214.5	100.0%

Source: IFPRI 1998 EWPS data

Combining information on the purchase of wheat products (in wheat equivalent) with information on wheat sales, we calculate the *net* sales of wheat by wheat farmers. The net position of households is important because it determines whether they would lose or gain from higher wheat prices in the absence of subsidies. Although two-thirds of Egyptian wheat farmers sell wheat, less than half (46 percent) are *net sellers,* whose wheat sales exceed the grain equivalent of their purchases of bread and other wheat products. Just 4 percent are self-sufficient, without purchases or sales of wheat or wheat products. One half of the Egyptian wheat farmers are *net buyers*, whose wheat purchases (expressed in grain equivalent) exceed their sales. Most of these households are wheat farmers that do not sell wheat at all and supplement their wheat production with purchases of bread and other wheat products.

4. WHEAT SUPPLY RESPONSE

This section uses the EWPS and multiple regression analysis to study the differences in household-level input use and output supply as a function of regional differences in input prices, output prices, and fixed factors available to the household. The model includes five equations: the supply of wheat and the demand for four variable inputs: hired labor, nitrogen-based fertilizer, phosphorus-based fertilizer, and agricultural machinery rental. We estimate jointly output supply and input demand using seemingly unrelated regression in order to impose the symmetry conditions associated with production theory. We focus on the wheat supply results (more details are provided in Kherallah *et al*, 1999).

The results of the regression analysis indicate that wheat supply is significantly affected by wheat prices, wage rates, nitrogen fertilizer prices, the education of the head of household, farm size, whether or not the farm is in the new lands, and buffalo ownership. Table 16 summarizes the price elasticities estimated from the model. The R^2 correlation coefficient for the wheat supply equation is 0.53, implying that approximately one half of the household-level variation in wheat supply can be explained by the model. The coefficient on the price of wheat is statistically significant at the 10 percent level and corresponds to a price

elasticity of wheat supply of 0.3. The supply elasticity would be somewhat larger in the long run because farmers are able to reallocate fixed factors toward or away from wheat production.

Table 16–Elasticities of output supply and input demand with respect to prices

	Elasticity of			
	Supply of wheat	**Demand for hired labor**	**Demand for N fertilizer**	**Demand for P fertilizer**
Price of wheat	0.301*	0.498**	1.577***	0.528
Wages	-0.021**	-0.422***	0.118*	0.216
Price of N	-0.048***	0.118*	-1.53***	2.204**
Price of P	-0.002	0.216	0.258**	-1.874*

Source: IFPRI 1998 EWPS data
* significant at the 10 percent level.
** significant at the 5 percent level.
*** significant at the 1 percent level.

The short-run supply elasticity of about 0.30 is in line with that observed in other developing countries (see Scandizzo and Bruce 1980). Thus in the short run, a ten percent increase in the price of wheat would induce farmers to allocate three percent more land for wheat cultivation. This suggests that farmers will react favorably to real and relative increases in rural wheat prices. This is particularly relevant in Egypt because it is a wheat deficit country and because the government seeks to purchase as much of its wheat requirement for the baladi bread and flour subsidy program from domestic sources.

Two of the three input prices are significant at the 5 percent level. The elasticity of wheat supply with respect to the wage rate indicates that a 10 percent increase in the wage rate would reduce wheat supply by 0.2 percent. Similarly, a 10 percent increase in the price of nitrogen fertilizer is associated with a 0.5 percent decrease in wheat supply. One implication of this finding is that a reduction in fertilizer price (due to a subsidy for example) would have only a modest effect on wheat production.

The size and composition of the household have no significant effect on wheat production, but the education of the head of household appears to have a significant positive effect on wheat production, perhaps reflecting greater managerial capacity.

The price of berseem (or clover) which normally competes with wheat, was tested in some alternative versions of the model but it was not statistically significant. Although normally we would expect a higher price of berseem to be associated with lower wheat production, this relationship may be weak or non-existent in Egypt because most berseem is retained for domestic use rather than sold.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The wheat production sector in Egypt has undergone significant changes since the beginning of the market reform programs in 1987. The removal of minimum wheat area requirements, the elimination of compulsory delivery of wheat quotas, and the liberalization of producer prices have increased the profitability of wheat-based crop rotations and led to the adoption of higher yielding varieties and modern production technology. The result has been a remarkable increase in wheat crop area and yields, causing wheat production to increase from 1.9 mmt in 1986 to about 6 mmt in 1998, or 46 percent of total consumption. Furthermore, the quantity of domestic wheat procured by the government for its 82 percent wheat flour and baladi bread subsidy program has increased from less than 0.1 mmt in 1986 to 1.8 mmt in 1998. However, the continued growth in domestic consumption has kept wheat imports in the range of 6 to 7 mmt per year.

The survey indicates that Egyptian wheat production is based on small-scale farms, yet these farms are highly commercialized. Wheat yields are high because of the intensive use of labor, fertilizer, and irrigation. Cooperatives continue to play an important role in seed distribution, but private traders have

come to dominate wheat marketing and the distribution of agricultural chemicals. Farmers buy fertilizer from cooperatives and traders in roughly equal amounts. Although some activities in Egyptian wheat production are mechanized, such as land preparation, water pumping, and threshing, ownership of tractors and threshers is rare. Mechanization is only possible because of the development of an active rental market in agricultural machinery.

Although Egypt's wheat production has grown substantially in recent years, the government has problems reaching its wheat procurement targets. A recurring question among policymakers is why such a small portion of national production is available for purchase by the government. Our results suggest that most of the wheat produced is consumed in the rural areas. Half is retained by wheat farmer households, 29-32 percent is purchased by the government, and the remainder is consumed by non-wheat-farming rural households and, to a lesser extent, wheat farmers who are net buyers. Using data from the EWPS, we estimate that roughly half of Egyptian wheat farmers are net buyers who complement their own production with the purchase of wheat products.

The survey also sheds light on why wheat farmers sell two thirds of their marketed surplus to traders rather than to cooperatives, mills, and village banks

that channel wheat directly to the government. The two main factors are price and location: traders pay prices at least as good as other buyers and they more often pick up the harvest on farm.

Given the high level of wheat consumption in rural areas, the cost of increasing deliveries of domestic wheat to the government are considerable. To do so, the GOE would have to increase the procurement price substantially above international prices. When procurement prices are above international prices, as they currently are, the government incurs the budgetary costs of subsidizing its wheat producers. In addition, increasing the incentive for farmers to sell the wheat they have set aside for home consumption will encourage them to purchase more subsidized flour and bread, resulting in higher costs to the consumer subsidy system.

Wheat self-sufficiency is often cited as a goal of Egyptian wheat policy. Achieving this goal using price policy would be very costly and ill-advised. This study finds that the supply elasticity of wheat is 0.3, implying that an increase in wheat self-sufficiency from 50 to 55 percent (that is, a 10 percent increase in wheat production) would require an increase in wheat prices of roughly 30-35 percent in the short run. This finding supports conclusions of an analysis by

Löfgren and Kherallah (1998). They find that raising the wheat self-sufficiency rate from 47 percent to 60 or 70 percent through higher producer prices would involve increased subsidy costs of LE 1.5 billion and LE 3.3 billion (0.7 and 1.6 percent of GDP) respectively. This result highlights the difficulty in achieving, or even increasing, wheat self-sufficiency through price policy alone.

Instead of subsidizing producer prices, the GOE would be better off investing in research and infrastructure. Government investment into research for the development of higher yielding wheat varieties would not only increase wheat production, farmer productivity and farm income, but should also help make more wheat available for the baladi bread and flour subsidy program without increasing per unit subsidy costs. Furthermore, as Egyptian agriculture and diets diversify into the production, export and consumption of higher-valued products, infrastructure investments would facilitate the marketing and export of these commodities.

ENDNOTES

1.Because the sample was selected in a four-stage process, the calculation of the weighting factor involves four terms:

$$W_g = \frac{DP}{P_d} \quad \frac{A_d}{SA_d} \quad \frac{G_d}{SG_d} \quad \frac{H_g}{SH_g}$$

where

W_g	=	weighting factor for basin group g in district d
D	=	number of districts selected
P	=	total wheat production in Egypt
P_d	=	wheat production in selected district d
A_d	=	total arable land in district d
SA_d	=	arable land in the MALR-selected basin groups of district d
G_d	=	total number of MALR-selected basin groups in district d
SG_d	=	number of IFPRI-selected basin groups in district d
H_g	=	total number of households in basin group g
SH_g	=	number of selected households in basin group g

The first term is a ratio of wheat production because the probability of selecting districts was proportional to wheat production. Similarly, the second term is a ratio of areas because MALR selected basin groups with probability proportional to arable land area. The third and fourth terms are the inverse of the proportion of units selected, reflecting the fact that the units (basin groups and households, respectively) were selected with equal probability.

2. All the statistics reported in Section 3 are weighted averages or percentages.

3. Each quintile groups 20 percent of the households, ranked by the value of their consumer durables. For example, the first quintile represents the 20 percent of households with the smallest value of consumer durables while the fifth quintile is made up of the wealthiest 20 percent of the households.

4. Results from Nubaria and the Frontier should be interpreted with caution because of the small sample size: 30 households in Nubaria and 20 in the Frontier.

5. The cropping intensity ratio is calculated as the sum of sown area across seasons divided by the annual cultivated area.

6. This figure is estimated by adding the total number of every-year wheat farmers to: twice the number of every-two-year farmers, three times the number of every-three-year farmers, and so on. This calculation adjusts for the undercounting of occasional wheat farmers in the sample.

7. The market surplus ratios are calculated as the total volume of sales as a percentage of the total volume of production. As a result, it is more influenced by the patterns of large producers than small producers.

8. There are two main commercial types of bread in Egypt: baladi bread (made from 82 percent extraction rate wheat flour) which is subsidized, and fino bread (made from 72 percent extraction rate wheat flour) which is sold at free market prices. Fino flour is usually considered of better quality than baladi flour.

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